Review Article

Review Article

Achromobacter xylosoxidans as emerging pathogen in healthcare settings: A mini review

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Abstract

Microorganisms of the genus *Achromobacter* have been mentioned as a cause of opportunistic infections, mainly in patients with cystic fibrosis or pulmonary lymphoma, with the species *Achromobacter xylosoxidans* being identified to a large extent. *A. xylosoxidans* was first described in 1971 and is an opportunistic pathogen. However, it been reported to cause chronic purulent otitis, meningitis, pneumonia, peritonitis and urinary tract infections, chronic obstructive pulmonary disease and other infections. The present literature review aims to analyze and synthesize the state of the art on *A. xylosoxidans* and its potential as an emerging pathogen in the healthcare settings. We discuss *A. xylosoxidans* as an emerging opportunistic pathogen that is associated with healthcare infections. This review further discusses the prevalence of *A. xylosoxidans* in healthcare settings, the types of infections it can cause, and the risk factors for acquiring an *A. xylosoxidans* infection. The review also covers the challenges in treating *A. xylosoxidans* infections, including its potential for drug resistance and the lack of specific treatments. Strategies for preventing and controlling *A. xylosoxidans* infections in healthcare settings were also discussed.

Keywords: *Achromobacter xylosoxidans*, *Achromobacter* spp, healthcare-associated infections, antibiotic resistance, preventive measure

Introduction

Microorganisms of the genus *Achromobacter* such as *Achromobacter xylosoxidans*, are Gram-negative, non-fermentative, and catalase and oxidase positive bacilli that are commonly found in aquatic environments and hospital areas [1, 2]. A sudden increase in infection cases caused by *Achromobacter spp* occurred in a hospital setting, where the investigators concluded that contaminated ampoules of a loop diuretic drug as the source of contamination [3]. A large scale biocontamination monitoring found that 10% of the total samples tested were positive for *A. xylosoxidans* contamination, where the prevalence was stable throughout the investigation time [2]. These bacteria are facultative aerobes, thus their survivability in both aerobic and anaerobic conditions [4].

A. xylosoxidans infections can range in severity, and the fatality of the disease can depend on several factors, including the type and severity of the infection, as well as the underlying health status of the affected individual [5, 6]. *Achromobacter* infections tend to affect immunosuppressed patients, and *A. xylosoxidans* is particularly known for its ability to form

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biofilms, leading to chronic and recurrent infections [7, 8]. In patients with immunosuppressed conditions, such as cancer or human immunodeficiency virus infection, *A. xylosoxidans* can cause severe infections, including pneumonia, sepsis, and bloodstream infections, which can be life-threatening [1, 5]. In other individuals, particularly those with intact immune systems, *A. xylosoxidans* infections may be less severe, causing skin and soft tissue infections, urinary tract infections, or chronic lung infections, among others [9, 10]. Moreover, this microorganism also tends to exhibit resistance to a broad spectrum of antimicrobials, making it difficult to treat, especially in cases where specific treatments are not available [11].

One of the reasons *A. xylosoxidans* is a concerning pathogen is due to its potential for drug resistance. *A. xylosoxidans* strains are often resistant to multiple antibiotics, including those commonly used to treat Gram-negative infections, such as carbapenems and aminoglycosides [11, 12]. This can make treating infections caused by *A. xylosoxidans* challenging, particularly in immunosuppressed patients who may have limited treatment options due to underlying health conditions or prior exposure to antibiotics [12]. Furthermore, the ability of *A. xylosoxidans* to form biofilms, which are communities of bacteria that are often more resistant to antibiotics and immune system defences, can contribute to chronic and recurrent infections that are difficult to treat [13, 14]. Overall, *A. xylosoxidans* is a concerning pathogen due to its potential for drug resistance and the difficulty in treating some types of infections it causes [15-17].

In addition to its drug resistance, another reason *A. xylosoxidans* is of concern is the absence of specific treatments for some types of infections caused by this pathogen. While some antibiotics may be effective in treating *A. xylosoxidans* infections [12], there is no consensus on the optimal treatment regimen, and treatment may need to be individualized based on factors such as the site and severity of the infection, as well as the antibiotic susceptibility of the strain [18]. This can lead to delays in appropriate treatment and potentially poorer outcomes for patients with *A. xylosoxidans* infections [19, 20].

The review discusses *A. xylosoxidans* as an emerging opportunistic pathogen that is associated with healthcare infections. It further discusses the prevalence of *A. xylosoxidans* in healthcare settings, the types of infections it can cause, and the risk factors for acquiring an *A. xylosoxidans* infection. The review also covers the challenges in treating *A. xylosoxidans* infections, including its potential for drug resistance and the lack of specific treatments. Strategies for preventing and controlling *A. xylosoxidans* infections in healthcare settings were also discussed.

Characteristics of *Achromobacter xylosoxidans* and its distribution

A. xylosoxidans, first described in 1971, is an opportunistic pathogen, mostly recovered from the airways, especially in patients with a history of idiopathic bronchiectasis or cystic fibrosis, but has also been reported in cases of chronic purulent otitis, meningitis, pneumonia, peritonitis and urinary tract infections, COPD, among others [15, 16, 21, 22]. They are non-fermenting, motile, gram-negative, peritrichous, non-spore-forming, aerobic, non-fermenting, aerobic bacilli microorganisms of approximately "0.8 x 1.2-3.0 GM" [15]. The shape and appearance of *A. xylosoxidans* have been presented in **Figure 1**, which have been published previously [17, 23]. It is worth noting that the microorganism has the ability to produce biofilms, enable it to attach on surfaces such as prostheses. This characteristic is a key factor in their pathogenic capacity [17, 24].

Clinical features

A. xylosoxidans is a rare opportunistic pathogen that can cause a variety of infections, including pulmonary, ocular, endocardial, and systemic infections [1, 25]. Clinical features of *A. xylosoxidans* infections are nonspecific and depend on the site of infection, but they may include fever, cough, dyspnea, chest pain, sputum production, fatigue, malaise, weight loss, ocular pain, blurred vision, endocarditis, and sepsis [19, 25]. A study in a large eye center in the USA, involving 28 patients suffering from *A. xylosoxidans* keratitis, revealed that 71.2% of the patients had poor

visual acuity (≤20/100) [19]. When *A. xylosoxidans* infects lung tissue, the patient could experience exacerbated pulmonary symptoms, in which the correlation has been found significant [26]. In a 10-year case series (n=13), major comorbidities included heart failure, malignancy in solid organs, and chronic liver disease [25]. *A. xylosoxidans* is often resistant to multiple antibiotics, which can complicate the management of infections caused by this organism. Therefore, early recognition and appropriate treatment are essential for successful outcomes.

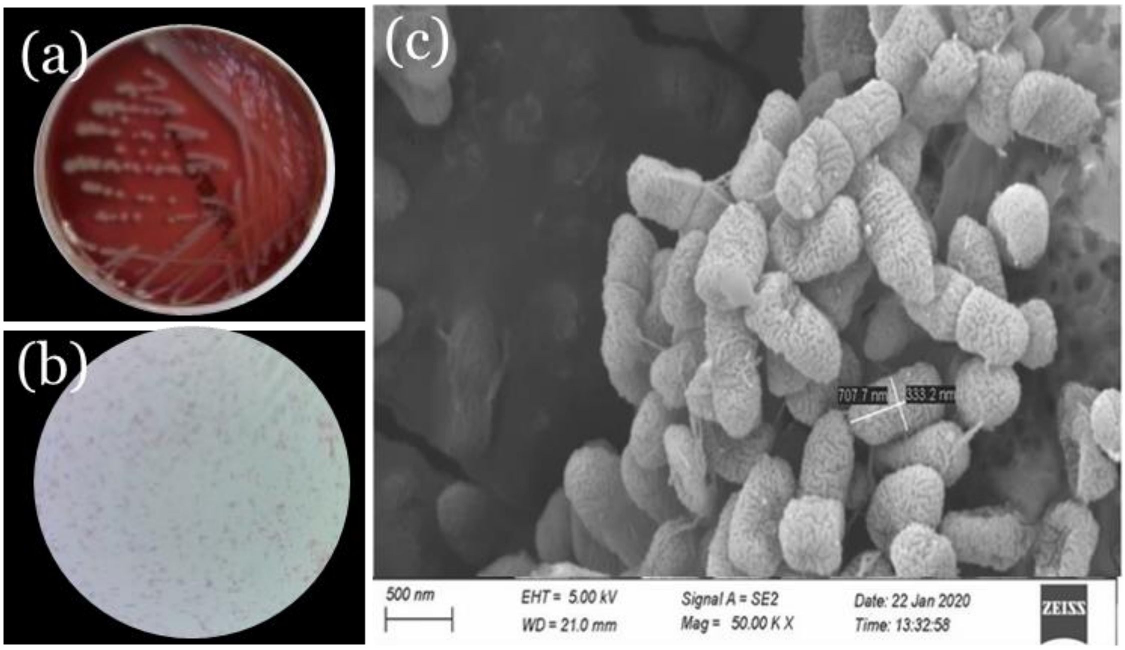


Figure 1. Photograph images of *A. xylosoxidans* in blood agar culture (a) and microscope observation (x1,000) of Gram-stained *A. xylosoxidans* (b). SEM image of *A. xylosoxidans* at magnification of 50,000x. Reproduced under a Creative Commons Attribution Non-Commercial License International License, citing [17, 23].

Global *Achromobacter xylosoxidans* infection cases in hospital settings

Search on the relevant literature was carried out on PubMed database on 23 September 2022 using keywords "*Achromobacter xylosoxidans*", "*Achromobacter spp.*", "human", and "case report" was used. Based on the search filters, 12 publications were found in the last 5 years that meet the criteria of being case reports and involving *Achromobacter* spp. or *A. xylosoxidans* in human samples (**Table 1**). The cases were reported from different countries, *viz* Japan (n=3), United Kingdom (n=2), Republic of Korea (n=2), India (n=1), USA (n=2), Sweden (n=1), Peru (n=1), France (n=1), and Croatia (n=1). The map showing the case distribution has been presented in **Figure 2**. Total number of patients reported were 14, where most of them were reported survived [6, 15-17, 22, 24, 27-29]. Ocular-, pulmonary-, and cardio-related comorbidities were found in multiple cases [6, 15-17, 29]. Interestingly, hyponatraemia was among the associated comorbidity [30]. The origin of the samples used for diagnosis varied across the studies, such as sputum [30], ear and/or lung swabs [15, 22], lung tissue [15, 29], and wounds [24]. The diagnostic tools used in the studies were culture-based methods [22, 24, 29], mass spectrometry [6], and molecular techniques such as polymerase chain reaction (PCR) and genome sequencing [21]. The infection can be treated successfully with antibiotics [6, 15, 17]; however, in others, the outcome may be fatal [16, 30].

Table 1. Reported cases of *Achromobacter xylosoxidans* in hospital settings from the last 5 years

Country of publication	Author, Year [Ref]	Related co-morbidities	Case, n	Immuno-competent (Yes/No)	Outcome (Dead/ Survived)	Origin of samples	Isolation or detection method
Japan	Aoyama et al., 2018 [21]	Mucosa-associated lymphoid tissue lymphoma B-cell lymphoma	1 2	Not reported Not reported	Not reported Not reported	Lung tissue	Polymerase chain reaction and DNA sequencing
United Kingdom	Bates et al., 2018 [15]	Idiopathic cystic bronchiectasis	1	Yes	Survived	Ear and lung tissue swabs	Culture
United Kingdom	Tavassoli et al., 2018 [6]	Corneal ulcer	1	Yes	Survived	Corneal scraping	Culture and mass spectrometry
Korea	Park et al., 2018 [17]	Cataract surgery	2	Yes	Survived	Anterior chamber and vitreous in case 1 and intraocular lens sample	Culture
India	Janarthanan et al., 2019 [27]	Systemic-onset juvenile idiopathic juvenile arthritis	1	Yes	Survived	Pericardial fluid	Blood and pericardial fluid cultures
USA	de Castro et al., 2020 [16]	Infective endocarditis of the non-prosthetic aortic valve	1	Yes	Survived	Prosthetic valve	Blood culture
Sweden	Ghali and Kim, 2020 [30]	Hyponatraemia	1	Yes	Dead	Sputum	Sputum culture
Peru	Toribio et al., 2020 [28]	Signal transducer and activator of transcription 3 (STAT3)-associated primary immunodeficiency loss-of-function	1	No	Survived	Pleural effusion	Culture
France	Lebeaux et al., 2021 [29]	Cystic fibrosis	1	Yes	Survived	Bronchialveolar lavage	Culture
Croatia	Velepic et al., 2021 [22]	Liver transplantation, tuberculous otitis media	1	No	Survived	Ear swab	Culture
USA	Sharifan et al., 2022 [24]	Traumatic tear of the right quadriceps tendon in sawing accident	1	Yes	Survived	Wound incision and drainage	Culture

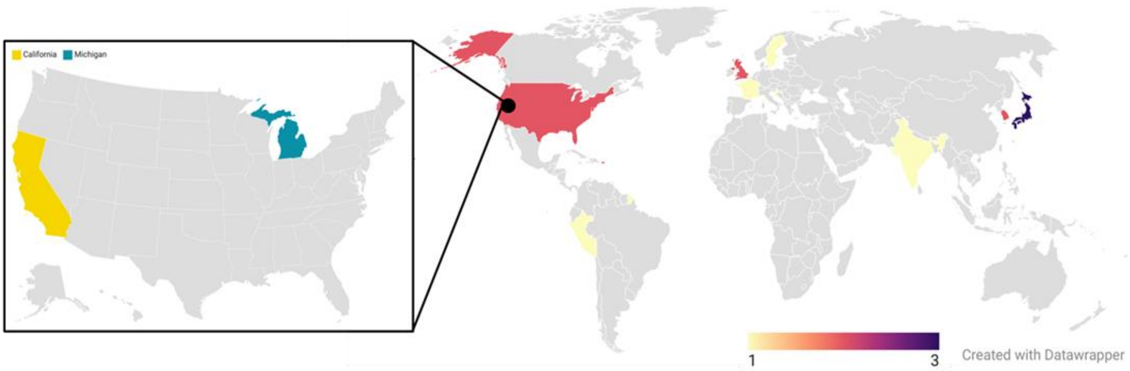


Figure 2. Distribution map of *Achromobacter xylosoxidans* infection cases in healthcare settings based on the retrieved studies.

Diagnosis

The diagnosis of *A. xylosoxidans* infection typically involves the isolation of the bacterium from a clinical sample, such as blood, sputum, or wound fluid, followed by identification through biochemical tests or molecular methods [22, 24, 29]. Magnetic resonance imaging (MRI) can be used in some cases to detect the presence of infection in certain areas of the body, such as the brain or soft tissues [31]. For example, a recent case report described the use of MRI to diagnose *A. xylosoxidans* pyomyositis in a patient with a history of trauma to the lower leg [15, 16, 27, 32, 33].

The MRI revealed features consistent with muscle inflammation and abscess formation, which were confirmed by culture and subsequent identification of *A. xylosoxidans* as the causative agent [31, 34]. However, MRI is not typically used as a routine diagnostic tool for *A. xylosoxidans* infections and is usually reserved for cases with suspected complications or unusual presentations [24].

Management of *Achromobacter xylosoxidans* infection

Antipseudomonal penicillins and carbapenems are effective therapies for treating infections caused by *A. xylosoxidans*. Antipseudomonal penicillins such as piperacillin-tazobactam inhibit the cell wall synthesis of bacteria, while carbapenems such as imipenem-cilastatin work by disrupting cell wall synthesis and destabilizing the outer membrane of bacteria [19]. These antibiotics have broad-spectrum activity against Gram-negative bacteria, including *A. xylosoxidans*, making them useful in treating infections caused by this organism. However, it is important to note that the choice of antibiotic therapy should be guided by susceptibility testing and the patient's clinical condition [16]. While the pathogen may be sensitive to certain antimicrobials such as piperacillin/tazobactam, ceftazidime, gentamicin, cefuroxime, quinolones, or meropenem, it is crucial to monitor the patient's response to treatment and adjust the regimen accordingly.

In the context of management, it is important to consider the potential for *A. xylosoxidans* to develop antibiotic resistance. In previous reports, some strains of *A. xylosoxidans* have been highlighted for being resistant to aminoglycosides and rifampin, and variable resistance to TMZ-SMX or ciprofloxacin [15, 16, 30]. Further, there are even cases that only responded to meropenem [15, 16, 30]. Potential use of phages in therapeutic research on these micro-organisms has been mentioned [29].

In patients with chronic diseases, such as cystic fibrosis or chronic obstructive pulmonary disease, the risk of developing antibiotic resistance may be higher due to repeated exposure to antibiotics. Therefore, a multidisciplinary approach is needed, including infection control measures, antimicrobial stewardship, and regular monitoring of patients with chronic infections. Additionally, efforts to develop preventive measures, such as vaccines, and improving hygiene practices in wet environments can also help reduce the incidence of *A. xylosoxidans* infections [15-17, 21, 27, 29, 30].

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Preventive measures

Recent research has focused on developing preventive measures against *A. xylosoxidans* infection. One potential strategy is the development of a vaccine, as discussed in a recent study [32]. This study demonstrated the potential of a recombinant protein-based vaccine to induce protective immunity against *A. xylosoxidans* in a mouse model. Antimicrobial prophylaxis has also been suggested as a preventive measure against *A. xylosoxidans* infection [35]. This approach involves the use of antibiotics to prevent infection in individuals at high risk, such as those with compromised immune systems.

Measures to improve hygiene in wet environments have also been proposed as a preventive strategy [36]. This includes regular cleaning and disinfection of surfaces and equipment in areas where *A. xylosoxidans* is commonly found. Disinfection of surgical equipment has been proposed as a strategy to prevent A. xylosoxidans infection [35]. This involves the use of disinfectants to eliminate bacteria on surgical instruments, reducing the risk of infection during medical procedures. Overall, these preventive measures offer promising avenues for reducing the incidence and impact of *A. xylosoxidans* infection. Measure strategies that could be used to prevent the transmission and infection of *A. xylosoxidans* have been presented in **Figure 3**.

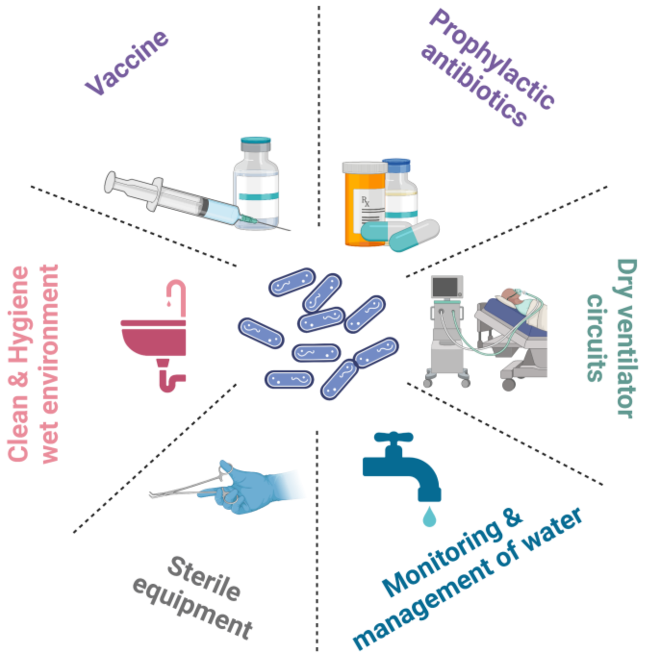


Figure 3. Preventive measures against infections of *Achromobacter xylosoxidans*

Conclusion

A. xylosoxidans is an emerging pathogen that has been increasingly reported in various clinical settings, particularly in patients with underlying chronic diseases and those exposed to broad-spectrum antibiotics. The pathogen has the ability to develop antibiotic resistance, making it a significant concern in clinical management. *A. xylosoxidans* is sensitive to various antimicrobial agents, including piperacillin/tazobactam, ceftazidime, gentamicin, cefuroxime, quinolones, and meropenem. However, as mentioned, the emergence of antibiotic resistance is a significant concern, particularly in patients with chronic diseases who are exposed to multiple antibiotics over time. Infection prevention measures, including vaccination, hygiene in wet environments, antimicrobial prophylaxis, and disinfection of surgical equipment, are crucial in reducing the incidence of *A. xylosoxidans* infections. Further research is needed to better understand the epidemiology, pathogenesis, and optimal management strategies for *A. xylosoxidans* infections.

Ethics approval

Not required.

Acknowledgments

None.

Conflict of interest

All the authors declare that there are no conflicts of interest.

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Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

How to cite

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